D-plate Beam Stop Engineering Review

Los Alamos, Feb. 6, 2002

by Michael Plum

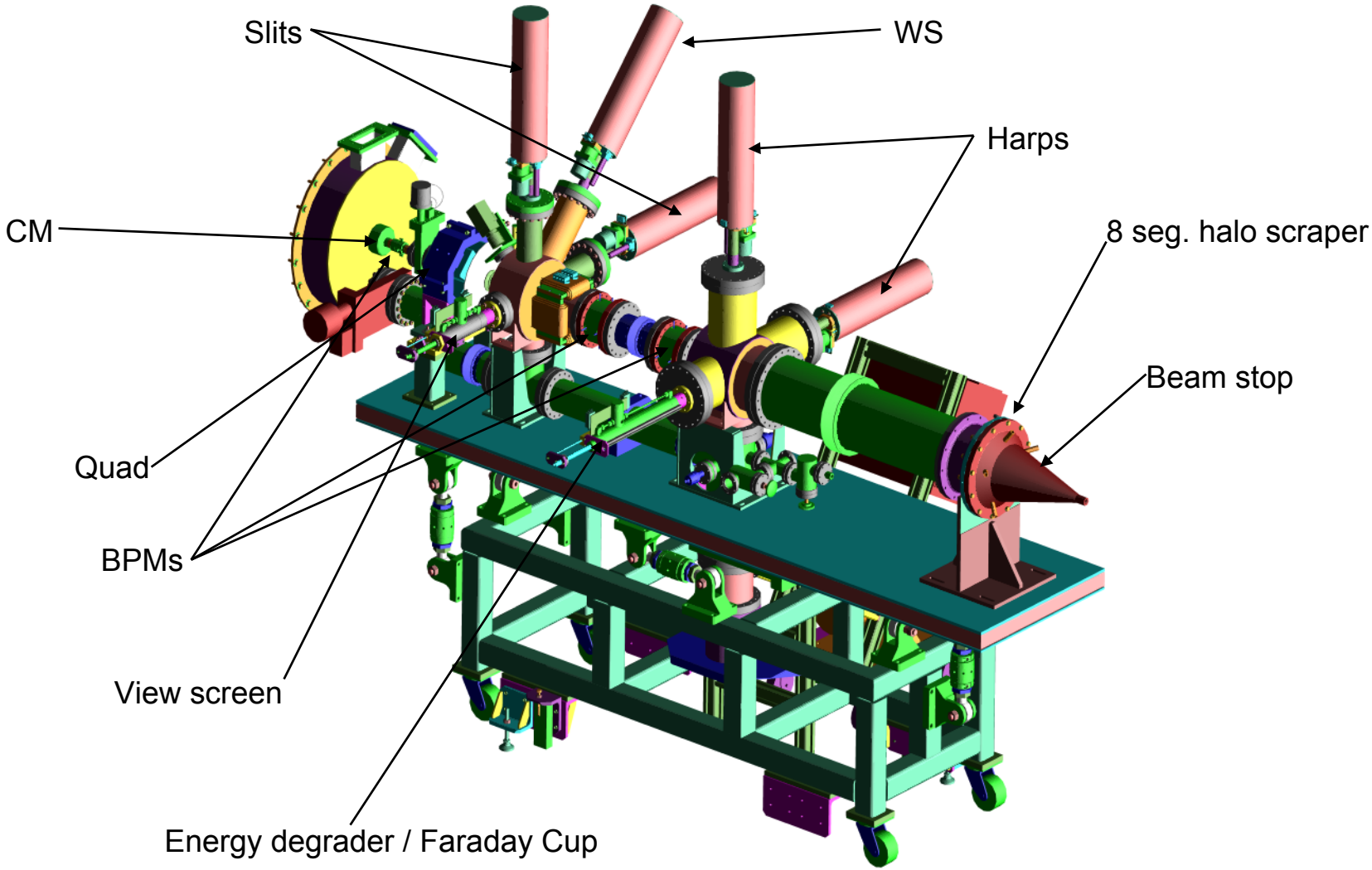
Review committee

- Kirk Christensen, Chairman, SNS-3
- Steve Black, ESA-TSE
- Will Fox, SNS-DO
- Jim Sims, ESA-DE

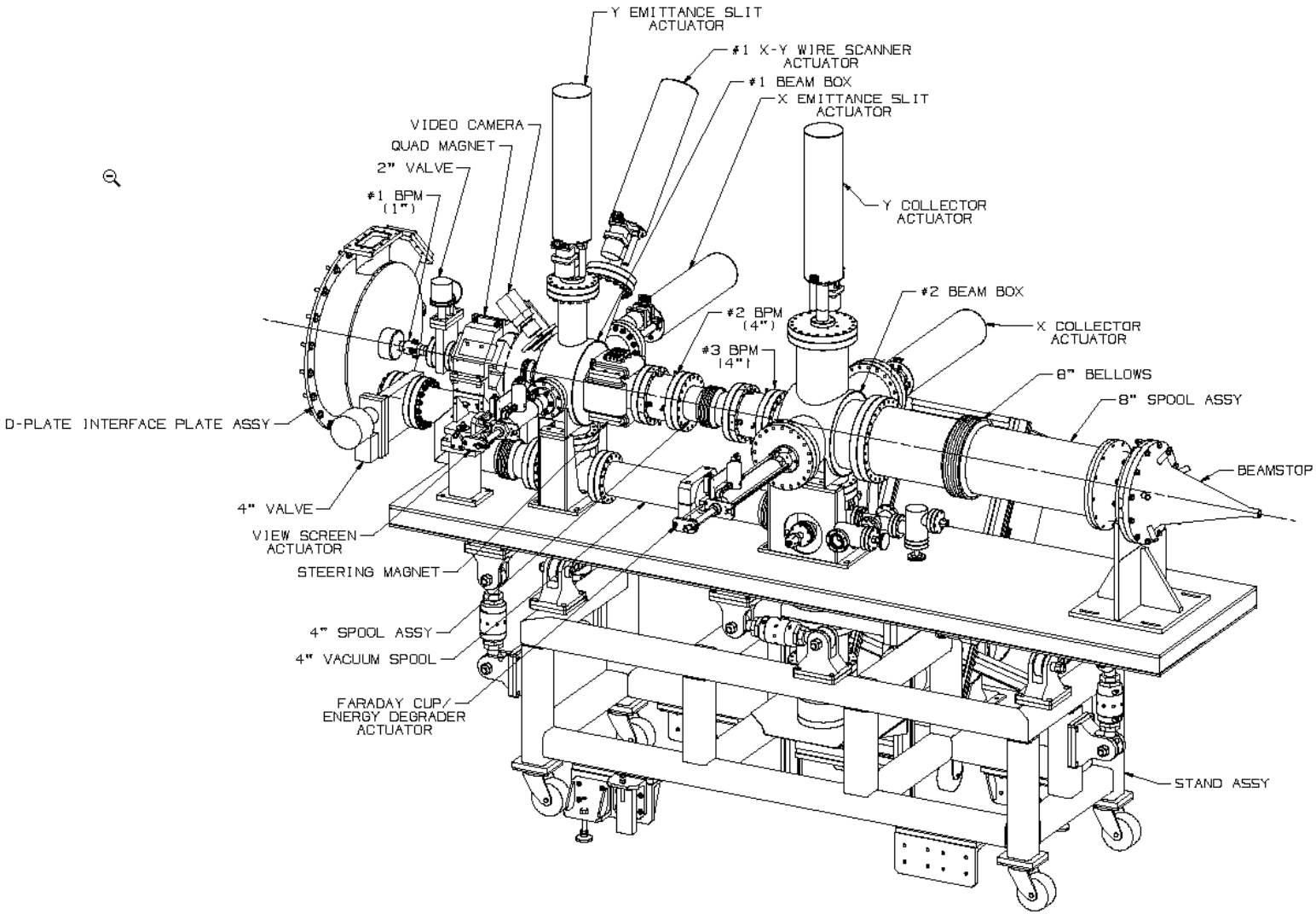
Agenda

- Introduction – M. Plum
- Details – S. Ellis
- Committee deliberations

D-plate overview



D-plate overview



Scope of this review

- **Engineering review of the beam stop only. Other components are covered by other reviews.**
  - If it is built as designed, will it meet requirements?
  - Are the safety factors adequate for this project?
  - Must stop full power beam (26 mA, 7.5 MeV, 1 ms, 60 Hz) without materials failure.
    - 11.7 kW average beam power in $x_{rms} = y_{rms} = 2$ cm beam spot.
  - Must also stop lower power beam with smaller spot size, needed for emittance tune.
    - 100 W average power in $x_{rms} = 1.7$ cm, $y_{rms} = 0.66$ cm beam spot.
    - 26 mA, 7.5 MeV, 50 us, 10 Hz.
  - Mis-steered beams (about 1 cm off axis) OK?
  - Operation for about 3 months total. Only a couple weeks at full power.

Charge to the committee

- Engineering review of the D-plate beam stop.
- Summarize in writing your observations and recommendations.

Usage scenarios

- **The D-plate will be used to commission the linac up to 7.5 MeV.**
  - Set DTL tank 1 phase and amplitude.
  - Check diagnostics in DTL tank 1 beam box.
  - Check upstream steering magnets.
  - Check match into DTL.

Failure scenario

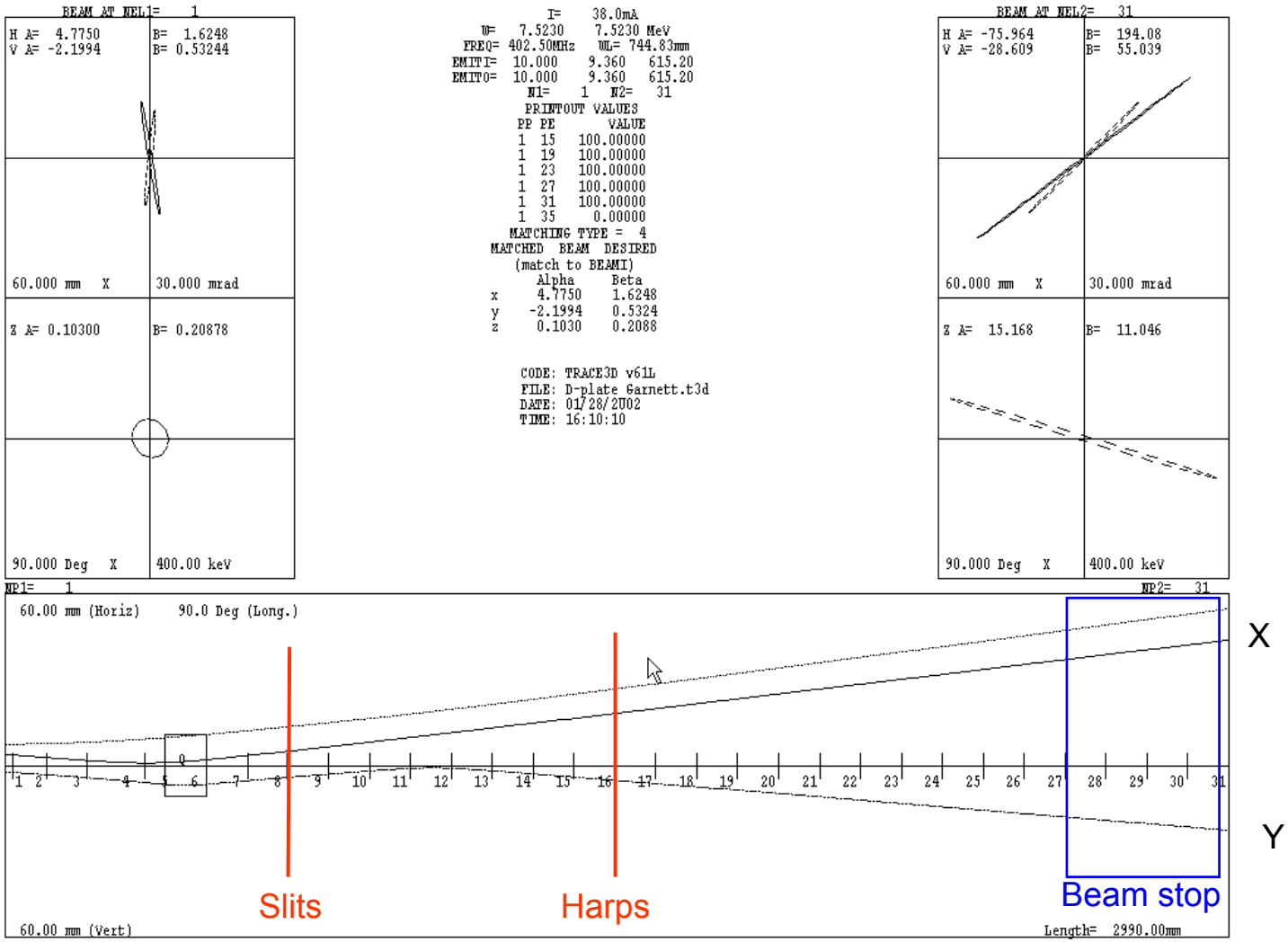
- Beam is somehow focused down to narrow beam spot, or beam stop fails.
- Hole is burned in nickel beam stop.
- Water sprays into vacuum system and destroys some beam line components and shuts down the linac for several weeks.
- Commissioning activities that require the beam stop cannot be completed.

D-plate tunes

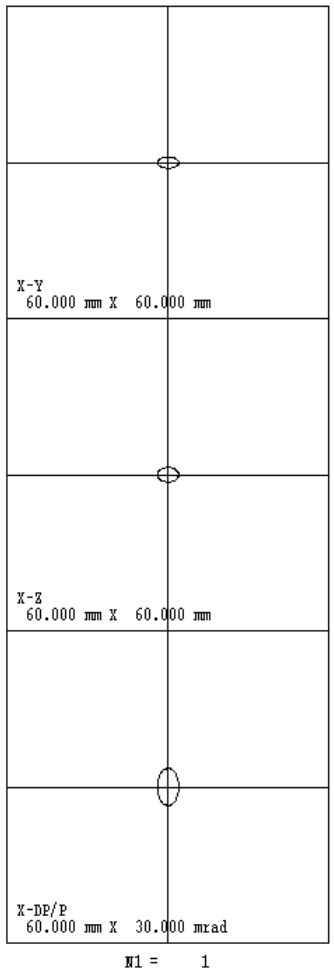
- **Two tunes used during normal operations, controlled by quad gradient (G).**
  - Emittance tune (G = 1450 G/cm)
    - Used during emittance scans.
    - Equal beam sizes at slits.
  - Beam stop tune (G = 2020 G/cm)
    - Used when running with high beam currents.
    - Equal beam sizes at beam stop.

- **Small spot tune (G = 1000 G/cm)**
  - This tune should be avoided to prevent damage to the beam stop.
  - Software interlock on quad magnet, so that if quad current readback strays outside of pre-defined windows, beam is automatically shut off.

Emittance tune (G = 1450 G/cm)

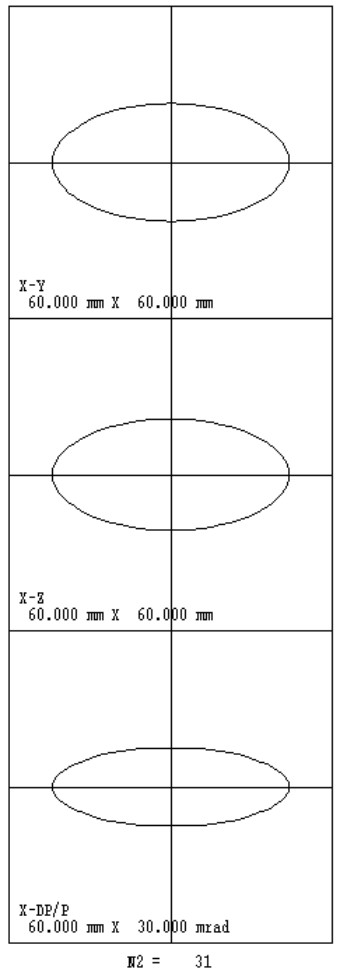


Emittance tune (G = 1450 G/cm)

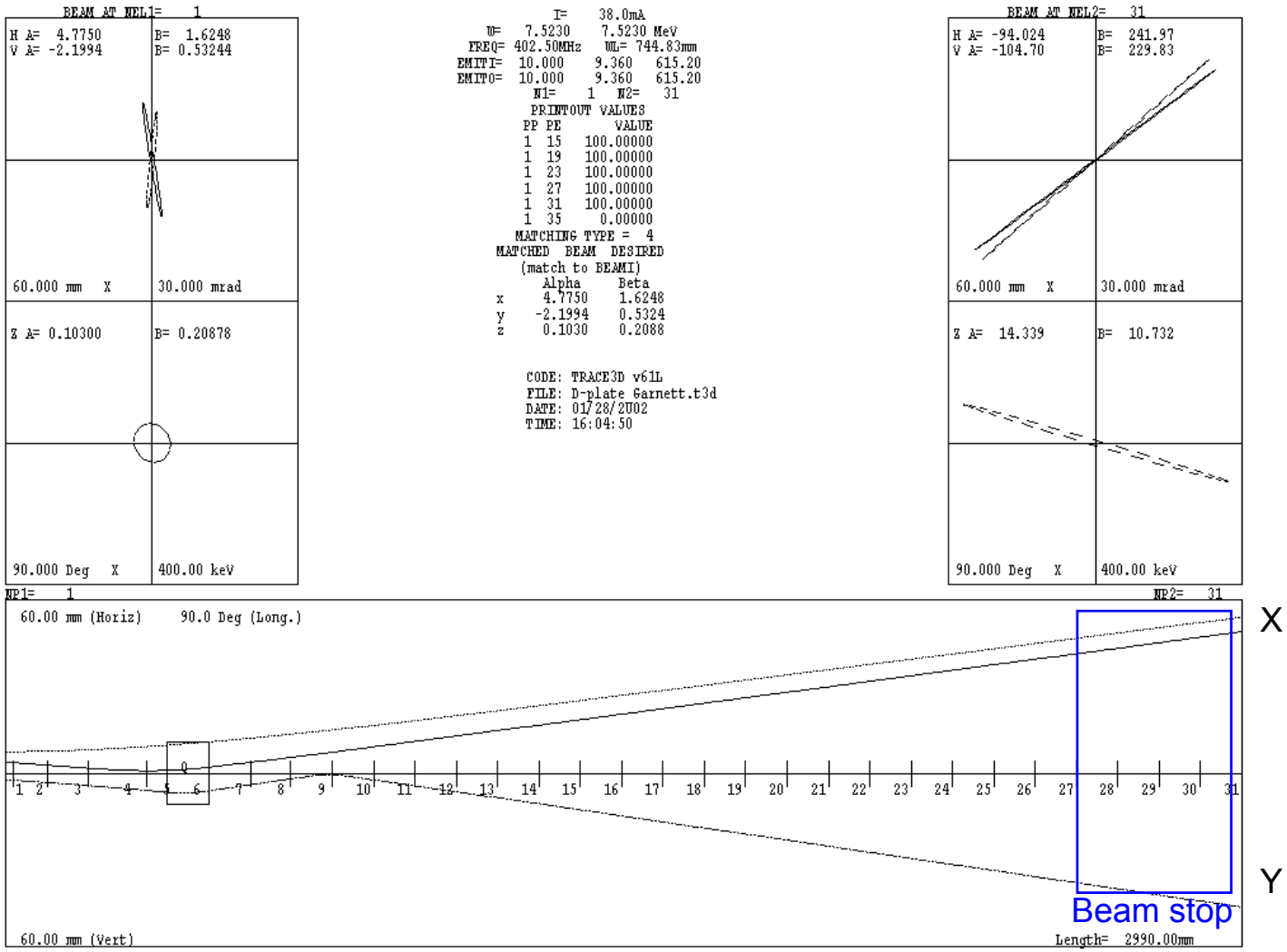


Xmax = 42 mm
Ymax = 20 mm

Xrms = 19 mm
Yrms = 8.9 mm



Beam stop tune (G = 2020 G/cm)



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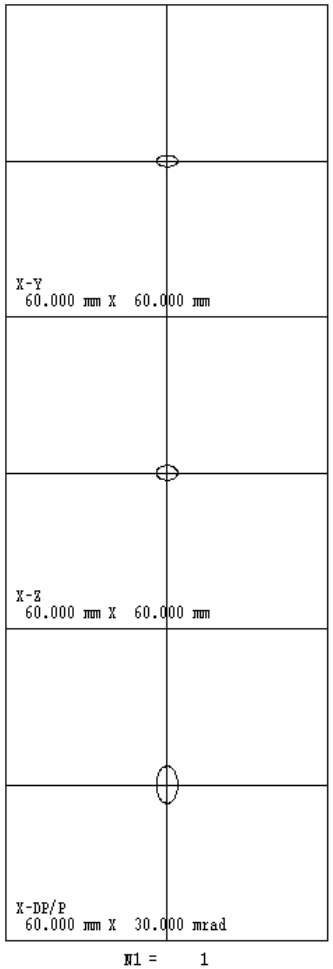
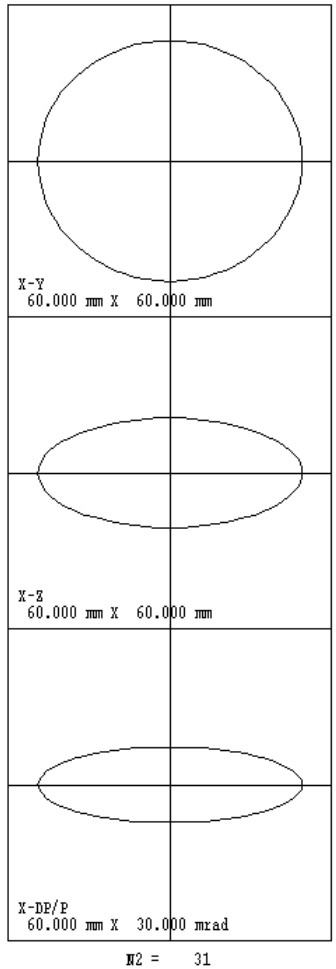
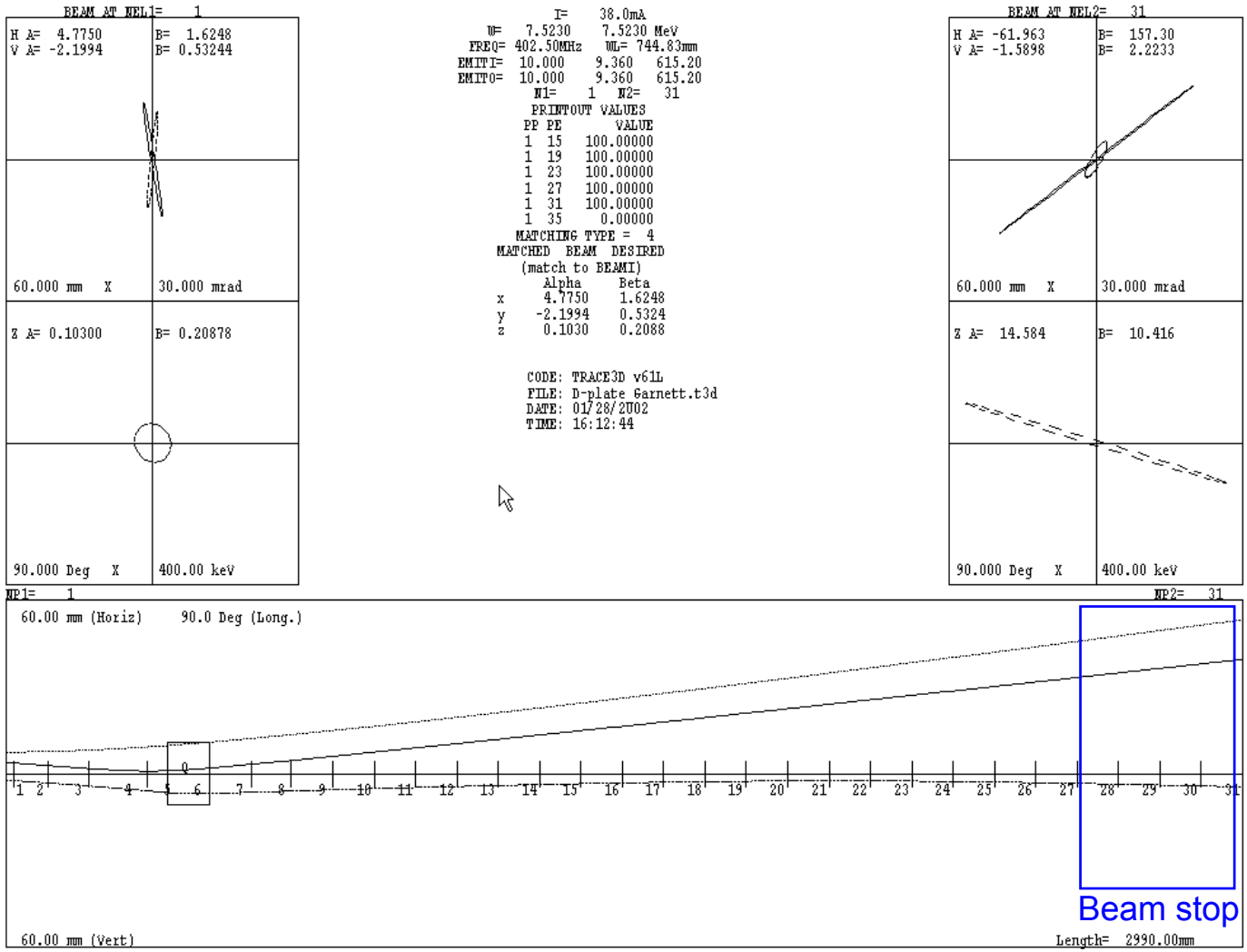


Xmax = 47 mm
Ymax = 45 mm

Xrms = 21 mm
Yrms = 20 mm



Small spot tune (G = 1000 G/cm)



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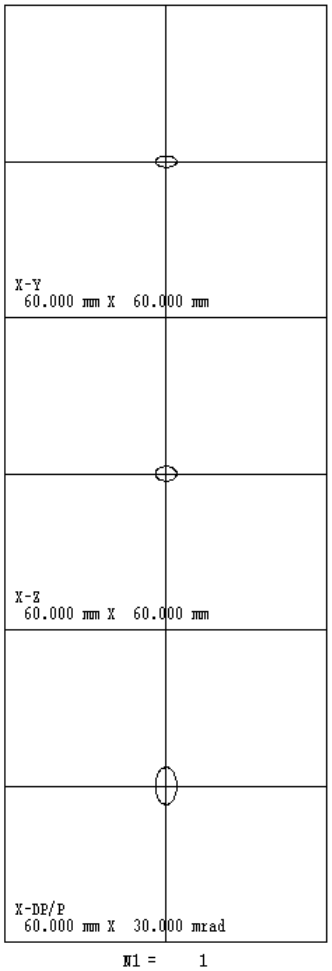
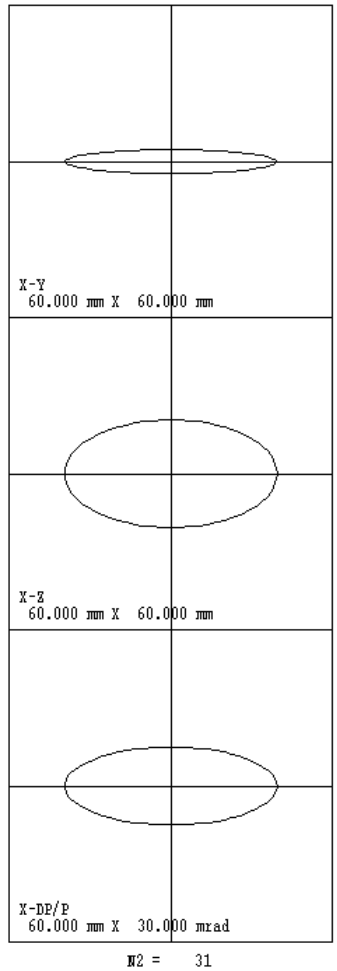


Xmax = 38 mm
Ymax = 4 mm

Xrms = 17 mm
Yrms = 1.8 mm

14 x more dense than beam stop tune.



Conclusions

- **Beam stop is part of D-plate, used to commission linac up to 7.5 MeV.**
- **Two normal modes of operation:**
  - high power, round beams.
  - low power beams with smaller spot size.
- **It is possible to focus the beam to a small spot that can lead to beam stop failure.**
  - Protection provided by control system monitoring quad current readback.
- **Consequences of beam stop failure are high.**

- **Steve Ellis will cover details of beam stop design…**